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DEVICE FOR FATIGUE WARNING IN MOTOR VEHICLES HAVING A RUN-UP ALARM SYSTEM

Background Information

The present invention relates to a fatigue warning device in motor vehicles, having a driver sensor system for detecting driver fatigue conditions and having a run-up alarm system which has an environment sensor system and is designed to output a warning signal and/or perform a regulating intervention in the drive and/or brake system of the vehicle when the distance to a preceding vehicle drops below a warning distance.

In a previous application of the present applicant, a device of this type was proposed in which the fatigue warning system is combined with an ACC (adaptive cruise control) system. ACC systems are already in practical use and typically include as an environment sensor system a radar sensor installed in the front of the vehicle, which locates preceding vehicles, and a controller which automatically intervenes in the drive or brake system of the vehicle if the distance to the preceding vehicle drops below a predefined setpoint distance. If the distance to the preceding vehicle increases again, the controller causes the vehicle to accelerate, so that the distance is automatically regulated to the setpoint distance. The setpoint distance is usually defined by what is known as time gap, i.e., the time interval between the preceding vehicle and the host vehicle passing a fixed point on the roadway.

In some systems of this type the driver has the option of setting the setpoint time gap himself within certain limits, for example, between one and two seconds.

In addition to ACC systems where automatic distance regulation is performed, run-up alarm systems are also known in which only a warning signal is output if the time gap drops below a setpoint value, referred to as a warning distance, while the driver is left to control the vehicle. In the present application, the term "warning distance" is used instead of the term "setpoint distance" even if actually not only a warning, but also intervention in the drive or brake system occurs.

In the device proposed in the previous application, if the driver sensor system detects a driver fatigue condition, the vehicle is forcibly decelerated and finally braked to a standstill. The risk of an accident is thus minimized by the combination with the distance regulating system. If the roadway in front of the host vehicle is free, the vehicle decelerates with a moderate deceleration rate so as not to irritate or put at risk the traffic following behind. In contrast, if a preceding vehicle is located by the environment sensor system, the host vehicle is decelerated more severely and more rapidly as a function of the measured distance, so as to prevent a collision with the rear of the preceding vehicle. The setpoint time gap set, however, is independent of the driver's fatigue condition.

WO 00/24309 A1 describes a fatigue warning system in which the driving impairment is established using a camera system which responds in particular to the driver's eyelid movements. If driving impairment is detected, this warning system is designed not only to output a warning signal and turn on the hazard warning lights, but also to initiate controlled braking to safely brake the vehicle to a standstill.

In most known fatigue warning systems, only a warning signal is output to the driver when a fatigue condition is detected, for example, an optical or acoustic warning signal or also a haptic signal, for example, in the form of vibration of the steering wheel. However, these systems are not easily accepted by drivers, because the driver feels bothered by frequent warning signals most of which are subjectively perceived as unjustified.

Advantages of the Invention

The present invention having the features recited in Claim 1 offers the advantage that the acceptance of the fatigue warning system is increased and yet a high degree of traffic safety is achieved.

For this purpose, according to the present invention, the warning distance on which the run-up alarm system or distance regulating system is based is modified as a function of the fatigue condition detected. If driver fatigue is detected, initially no warning signal is output; only the warning distance is increased. The warning signal is not output until the distance to the preceding vehicle drops below the now increased warning distance. In this way, increased traffic safety is achieved without bothering the driver with unnecessary signals by increasing the response time available to the driver when tailgating the preceding vehicle. Instead of, or in addition to, outputting a warning signal, the vehicle may also be automatically decelerated by the distance regulating system. This deceleration of the vehicle occurring at an unusually great distance is usually noticed by the driver and therefore also has the function of a "gentle" warning signal which is therefore acceptable to the driver.

Advantageous embodiments and refinements of the present invention result from the subclaims.

The warning distance is preferably defined by a setpoint time gap, as used in distance regulating systems or ACC systems. In systems where the driver is allowed to set the setpoint time gap manually, the device according to the present invention is preferably designed in such a way that the automatic increase in the setpoint time gap overrides the driver's manual setting. The setting range provided for manual setting may also be exceeded upward if fatigue is detected.

It is advantageous to visualize the fatigue condition detected using an optical display on the dashboard in such a way that the response of the run-up alarm system or distance regulating system which is unusual for the driver is made transparent.

Drawing

An exemplary embodiment of the present invention is depicted in the drawing and elucidated in detail in the description that follows.

Fig. 1 shows a block diagram of the device according to the present invention, and

Fig. 2 shows a diagram for elucidating the modification of a setpoint time gap as a function of the fatigue condition.

Description of the Exemplary Embodiment

Figure 1 shows, as a block diagram, an ACC control unit of a motor vehicle formed by one or more microprocessors, which receives signals from an environment sensor system 12, for example, from a radar sensor installed in the front of the vehicle and, on the basis of the measured distance and the relative velocity of a preceding vehicle, intervenes in drive system 14 and/or brake system 16 of the vehicle to regulate the distance to the preceding vehicle to a setpoint distance (warning distance) defined by a setpoint time gap. These

regulating functions are performed as known by a controller 18 of ACC control unit 10.

In addition, the device according to the present invention has a driver sensor system 20, which is able to detect the driver's fatigue condition. This driver sensor system 20 may be formed, as known, for example, by a camera system and an electronic image analyzing system which responds to the driver's eyelid movements. Optionally or additionally, however, other criteria may also be used for recognizing fatigue conditions, such as, for example, the frequency of relatively abrupt steering interventions by the fatigued driver for keeping the vehicle in its lane. If environment sensor system 12 also includes a camera system directed to the roadway for recognizing the roadway boundaries, the frequency and degree of deviations from the center of the lane may also be directly registered.

Driver sensor system 20 is preferably designed in such a way that it statistically analyzes the frequency of signs of driver fatigue and computes a quantitative parameter E (degree of fatigue) from this statistical data.

ACC control unit 10 furthermore contains a setting device 22, which determines a setpoint time gap Δt which is then used as a basis for the distance regulating function or distance warning function in controller 18. An operator's control 24 connected to setting device 22 allows the driver to set time gap ΔT to be used within a limited setting range of one or two seconds, for example, under normal conditions, when no fatigue exists.

Degree of fatigue E is transmitted by driver sensor system 20 to setting device 22 and is used there for modifying setpoint time gap ΔT as a function of the fatigue condition.

An example of the modification of the setpoint time gap performed automatically in setting device 22 is graphically

illustrated in Figure 2. For a degree of fatigue E = 0, the setting manually made by the driver using operator's control 24 applies. Setpoint time gap ΔT thus set is within the setting range of one to two seconds. With increasing degree of fatigue, setpoint time gap ΔT increases linearly as shown by solid curve 26 in Figure 2. As fatigue increases, this modified setpoint time gap may also exceed the upper limit of the setting range of two seconds. Finally at a certain degree of fatigue, the setpoint time gap reaches a maximum value, which in the example shown is 3 seconds, and it then remains constant even at a higher degree of fatigue.

This automatic increase in the setpoint time gap as a function of degree of fatigue E makes it possible to increase the warning distance or, in the case of an active distance regulating function, the setpoint distance at which a preceding vehicle is followed as the degree of fatigue increases, so that the response time which becomes potentially longer in the event of driver fatigue is taken into account.

If the driver has set or sets a longer setpoint time gap within the setting range of one to two seconds, the setpoint time gap is modified as shown by curve 28 which is drawn as a dashed line in Figure 2. Also in this case, the setpoint time gap is increased linearly to a maximum value and then remains constant. Even if the driver attempts to re-adjust the setpoint time gap using operator's control 24 and sets it to the maximum possible value of two seconds, for example, in the event of a higher degree of fatigue a forced increase in the setpoint time gap takes place, which the driver is unable to compensate. Increased traffic safety is thus achieved, while the driver is discreetly prompted to take a rest.

Normally, the driver is able to deactivate the ACC function at any time by inputting an appropriate command. The device proposed herein may, however, also be designed in such a way that the ACC function is forcibly activated and cannot then be

deactivated by the driver if degree of fatigue E exceeds a certain threshold value.